

Diagnostic Operational Modeling

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16. Abstract (Limit: 200 words) ✓ This manual describes the physical set-up of the computer system and presents several important "do's and don'ts" intended to prevent the user from damaging the computer or the diskettes. Chapter 3 contains a step-by-step description of how to run the programs and obtain numerical and graphical output. Chapter 4 presents guidelines for interpreting the program output and a discussion of the limits of accuracy of the programs. These programs have been prepared for use with the Apple II plus minicomputer. The Diagnostic Operational Modeling Programs are intended to provide a reliable and rapid means of identifying process limitations and operational deficiencies. Programs for the following ten types of municipal wastewater treatment plants are available: 1) primary treatment, 2) conventional activated sludge, 3) single stage activated sludge for nitrification, 4) extended aeration activated sludge, 5) extended aeration oxidation ditch, 6) contact stabilization, 7) single stage trickling filter, 8) two stage trickling filter, 9) activated Bio-Filter, and 10) rotating biological contactors. These programs allow the option of an anaerobic or aerobic sludge digestion analysis.			
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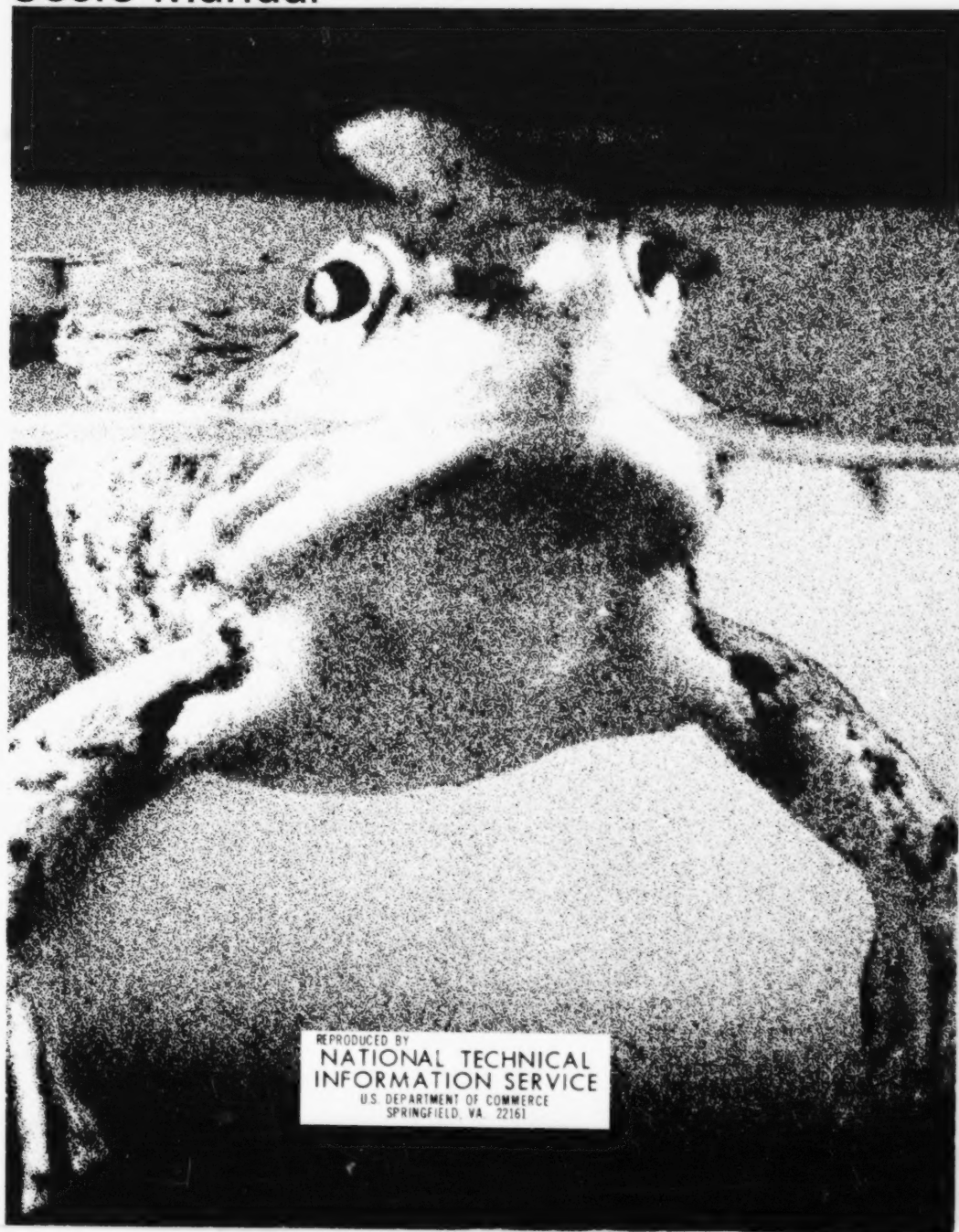
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Diagnostic Operational Modeling Programs for Municipal Wastewater Treatment Plants

Users Manual



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DIAGNOSTIC OPERATIONAL MODELING PROGRAMS
FOR
MUNICIPAL WASTEWATER TREATMENT PLANTS
USERS MANUAL

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CHAPTER 1

INTRODUCTION

In general, undesirable effluent quality from municipal wastewater treatment plants results from one of two general causes. The first is that treatment plants become overloaded or do not have adequate capacity in one or more unit processes to produce effluent of a desired quality. The second is that plants are not being operated properly. In this manual, the former will be referred to as a "process limitation" and the latter will be referred to as an "operational deficiency." Distinguishing between the two is not always easy. The Diagnostic Operational Modeling Programs are intended to provide a reliable and rapid means of identifying process limitations and operational deficiencies. Programs for the following ten types of municipal wastewater treatment plants are available:

1. Primary treatment
2. Conventional activated sludge, with or without primary sedimentation
3. Single stage activated sludge for nitrification, with or without primary sedimentation
4. Extended aeration activated sludge with or without primary sedimentation
5. Extended aeration oxidation ditch with or without primary sedimentation
6. Contact stabilization, with or without primary sedimentation
7. Single stage trickling filter with primary sedimentation
8. Two stage trickling filter with primary sedimentation
9. Activated Bio-Filter, with or without primary sedimentation
10. Rotating biological contactors with primary sedimentation

These programs allow the option of an anaerobic or aerobic sludge digestion analysis.

These programs have been prepared for use with the Apple II plus minicomputer. Separate diskettes have been prepared for each of these programs. Each diskette allows both numerical and, combined with the Plot Program and Data Disk (to be described later) graphical presentation of treatment plant performance capabilities, with several options as to how this information is presented. There is also room left on each diskette to store files containing data on the physical configuration of up to 77 treatment plants. This saves time when making many runs on the same plant.

The subsequent three chapters of this manual describe how to use the Diagnostic Operational Modeling Programs.

Chapter 2 describes the physical set-up of the computer system and presents several important "do's and don'ts" intended to prevent the user from damaging the computer or the diskettes.

Chapter 3 contains a step-by-step description of how to run the programs and obtain numerical and graphical output. This chapter also contains several important recommendations and warnings about storing and using the diskettes.

Chapter 4 presents guidelines for interpreting the program output and a discussion of the limits of accuracy of the programs.

Before using the Diagnostic Operation Modeling programs for the first time, it is recommended that the user read through the first three chapters of this manual, as well as appendices which are referenced in those chapters.

Note: Before using the Apple computer for the first time, it is strongly recommended that the user read the users manuals for the computer, printer, disk drives, and cathode ray terminal (CRT, or TV monitor) provided by the manufacturers.

Taking the time to read these other manuals will greatly reduce the chance of accidental damage or misuse of this equipment. It will also save a great deal of time in the long run, and make using the computer more enjoyable.

1.1 Limitations

In general, a maximum of ten individual treatment units per type of unit process is allowed (i.e., ten primary clarifiers, ten aeration basins, ten RBC's per RBC train, etc.). If a plant has more than ten of any type of treatment unit, the plant can still be accurately modeled by using, for example, half the flow with half the actual number of units. To do this, all the units would have to be of the same size and configuration. If not, the user must exercise his own judgment in deciding whether or not he can approximate the actual plant configuration in some way which results in less than ten units for each unit process.

CHAPTER 2

USING THE COMPUTER

This chapter presents a non-technical discussion of how to prepare the Apple II plus computer for use with the Diagnostic Operational Modeling Programs. It is based on the combined experience of the individuals who developed the program formats specifically to be used on this computer system, and is meant to be as simple and foolproof as possible. We recommend that users follow the procedures in this chapter carefully until they are thoroughly familiar with the programs, as well as the capabilities and limitations of the computer itself, before attempting to modify these procedures in any way.

Note: This chapter is not a substitute for manufacturers' manuals provided with the computer hardware. Those manuals must be read carefully before following any instructions in this manual.

2.1 Computer System Components

The program formats were developed using the following standard components:

1. Computer -- Apple II plus with 48K random access memory (RAM)
2. Disk Drives -- Two Apple II disk drives with controller card
3. CRT -- Various manufacturers
4. Dot Matrix Printer -- Epson MX-80 with graph tracks
5. Clock -- Mountain Hardware Apple clock
6. Diskettes -- 5¼ inch diameter, various manufacturers

The first step in running the programs is to set up the computer in a suitable work area. A table or desk at least two feet wide and

four feet long will be required to hold the computer without crowding. Additional work space, particularly an "L" shaped arrangement, is very helpful. The computer, printer and CRT each require a 110 volt power supply. Power cords should be kept out of the way to avoid accidental unplugging of the equipment. Set the computer in the center of the work space. Place the disk drives on top of each other, with Drive No. 1 on top, and to the right of the computer. Place the printer to the left of the computer. The CRT can either be placed directly on top of the computer or directly behind it. The clock is kept inside the computer itself.

After reading the manufacturers instructions carefully, plug the printer and the CRT into the computer. The disk drives should already be connected to it. Make sure that the main power switches on the computer, printer and CRT are turned off, and then plug these units into the power source.

Note: Do not turn on the power to any of these units yet.

2.2 Computer

The computer is the heart of the system. The keyboard provides the user with a means of entering data and commands for the computer to act on. Commands given internally by the computer activate the printer and disk drives while the Diagnostic Operational Modeling Programs are being run.

It is very important that the computer (and all other system components) and the area around them be kept clean and dry. Use a dry or lightly moistened dust cloth for cleaning. Avoid using too much water. Do not use any cleaners whatsoever. Never put open beverage containers, flower vases, etc., on the table where the computer is kept, or on overhead shelves near the computer. Excessive moisture can severely damage or destroy the computer.

Note: The computer, when in operation, will cause electrical interference to some instruments and most radio and television receivers.

Note: After a period of time, the electrical contacts inside the computer may oxidize and cause apparent malfunctions when running the programs. The circuit boards can be removed and the contacts gently cleaned with a soft vinyl (non-abrasive) eraser or with cleaning compounds developed specifically for this purpose. The power to the computer must be shut off before the circuit boards are removed. Removing circuit boards while the power is on can severely damage or destroy the computer.

2.3 Disk Drives

Two disk drives are provided to store and read programs and data. They are not interchangeable. Drive 1 is used to read in the Diagnostic Operational Modeling Programs, treatment plant configuration files, and the Plot Program. Drive 2 is used to store data from the main program runs for use with the Plot Program. This will be discussed in more detail in Chapter 3.

When in use, each drive holds only one diskette. To insert a diskette into the drive, first push in the top of the flap on the front of the drive. It will flip up and allow access to the horizontal slot in the front of the drive. Diskettes are stored in protective paper packets. Remove the diskette from the packet by holding it so the label is on top and in the lower right corner as you look down at it. Put your right thumb over the label, and gently remove the diskette from the packet, and insert it into the drive without turning it so that the label remains on top and in the lower right corner as you look down at the drive. Close the drive by pushing down on the plastic flap until it flips back down.

Note: Never let anything touch the brown or grey surface of the diskette. Handle the diskette by the plastic cover only. Always keep diskettes in the paper packet when they are not in use.

Note: Never turn the computer on unless there is a diskette in Drive 1. It is not necessary to have one in Drive 2.

To remove a diskette, simply open the drive door by pushing in on the top of the flap. Carefully pull the diskette out of the drive, and put it back in the paper packet.

Note: Always check the "in use" light on the drive before removing diskettes. Never remove a diskette while the "in use" light is on. This can destroy the information on the diskette.

Note: Don't leave diskettes in the drives overnight.

Note: The disk drives require cleaning periodically to remove dirt and magnetic particles from the read/write head. Cleaning kits with instructions are available from most computer stores.

2.4 CRT

Many CRT's are available from various manufacturers for use with the Apple computer. They vary widely in detail and in orientation of controls, so the user should become familiar with the one provided. Eyestrain is a common symptom of heavy computer use, so take some time to place the CRT where it is easiest to look at for long periods of time. Changing contrast and brightness settings may be helpful if lighting conditions in the room change during the day.

Note: Many users have found that looking at the CRT for long periods of time under fluorescent lights gives them headaches. This is caused by the screen and lights flickering together very quickly. This problem can be minimized by changing to incandescent lighting or taking breaks at regular intervals.

2.5 Printer

The users manual prepared by the manufacturer contains all the information needed to use the Epson MX-80 dot matrix printer properly. Therefore, normal operating instructions will not be repeated in this manual.

One addition to the normal instructions which previous program users have found handy is to place a standard office-type "in-out" basket behind the printer to receive the output. Paper going into the printer should run underneath the basket. When properly arranged, the output will fold itself neatly in the top part of the basket and prevent output from being fed back into the printer, which jams the machine. This allows the user to devote attention to other matters while a run is being printed.

2.6 Clock

This is the only piece of hardware that you really don't see. It consists of a printed circuit board inside the computer. The manufacturer's manual describes how to set the clock initially, and how to reset it if the clock's power supply fails.

The clock has a backup battery attached to it, so that when you turn off the computer the correct time remains in the clock. The battery takes three days to fully recharge, either by leaving the computer on or using the 9 volt adapter provided. After the battery is fully charged you can turn the computer off overnight or over the weekend. If you plan to not use the computer for more than three days, you should plug in the 9 volt adapter. Instructions for using the adapter are included in the manufacturer's manual.

2.7 Diskettes

Diskettes are very similar to cassette tapes except in physical ways. Therefore, you must use the same precautions to keep them from being damaged. These include the following:

1. Never put a diskette in a hot area such as in the sunlight area of a window or near an oven, heater, electrical panel or lamp.

2. Keep the diskettes away from magnetic fields at all times. This includes: motors, instruments, magnets, metal cabinets, electrical cords, etc.
3. Store the diskettes in a cool dry place. Moisture can cause fatal damage to the surface area of the diskette. Diskettes should be stored vertically in a closed container. Special storage containers are available from most computer stores.

Since the diskettes can be damaged very easily and since it is nearly impossible to "repair" a damaged one, it is strongly recommended that each user center keep two complete sets of diskettes. One set should be a working set available for day-to-day use. The second set should be retained as a backup in case something happens to a working diskette. If a working diskette becomes damaged or is lost, the backup diskette should be used as the working diskette and another copy obtained to become the new backup diskette.

Note: The Diagnostic Operational Modeling Programs cannot be listed, edited, or copied except by authorized personnel.

CHAPTER 3

RUNNING THE PROGRAMS

This chapter contains instructions on how to run the Diagnostic Operational Modeling Programs and the Plot Program. These programs are conversational in nature, which means that the computer will ask the user a series of questions before the computations start. The answers to these questions will guide the computer in its work. The emphasis of this chapter is to explain to the user how each of these questions affects the computations so that users can obtain output best suited to their needs.

The question and answer format of each program is intended to be easy to follow. The majority of the questions asked refer either to the physical configuration of the plant to be modeled or to the wastewater characteristics to be used in the run, and are self-explanatory. For this reason, not all of the questions the user will need to answer are specifically addressed in this manual. The user should understand that incorrect answers will not hurt the programs in any way but will affect the output.

Before proceeding, the user is advised to prepare data sheets with the wastewater characteristics and plant configuration to be used in the run. Forms which indicate the necessary information are contained in Appendices B and C of this manual.

3.1 What the Computer Does

The Diagnostic Operational Modeling Programs simulate the performance of municipal wastewater treatment plants under steady state conditions for a series of twenty evenly-spaced flows beginning at 75 percent of the average dry weather flow and increasing to 130 percent of

the plant's design flow. The computer begins each run by printing out a title page, and then prints out the wastewater characteristics and treatment plant configuration used in the run. Values for nearly all significant operating parameters are then printed out for each unit process at each incremental flow. Wastewater characteristics are held constant throughout each run.

The user has a choice of several options each time a program is run. The first option the user has is to use previously stored data on the configuration of a particular treatment plant, or to enter new data. If the user elects to enter new data, the second option the user has after entering all the new data is whether or not to save the data just entered for future use.

If the plant being run has digesters, the user has the option of having or not having a digester analysis printed out. Not requesting a digester analysis saves some time on each run.

The user also has the option of saving the values computed in each run for plotting after the run is completed. In order to take advantage of this capability, the user must have a "Data Disk" available to insert in Drive 2 during the main program run, and must also switch diskettes in Drive 1 after the main program run is completed. If the user does not wish to exercise this option, neither of these steps are necessary. This will be discussed in more detail a bit later in this chapter.

The user also has the option of using the clock to record the date on each output page of the computer printout, and of adding one line of comments to the bottom of the title page of each printout.

These items have been presented in approximately the order in which they appear to the user. Each will now be discussed in more detail. At this stage, the user should have the computer itself assembled and ready to go, the program data and plotting diskettes at hand, and all the necessary input data ready.

3.2 Beginning the Run

The last steps the user should perform before beginning a first run are the following:

1. Load paper into the printer. Advance the paper so that a horizontal perforated line is about $\frac{1}{4}$ inch above the top of the print head.
2. Put the main program disk in Drive 1.
3. Turn on the power to the computer, CRT and printer. Hit the printer "On Line" button to make sure it lights, then hit it again to make the light go out.

At this point the "in use" light on Drive 1 should come on, and the drive will whir and clack for a few seconds. Then a message will appear on the screen giving the user certain information. Using the "Conventional Activated Sludge" diskette, for example, this first message would read

CONVENTIONAL ACTIVATED SLUDGE DISK

YOU SHOULD HAVE THE CONVENTIONAL A.S. DATA DISK

IN DRIVE 2

1. CONVENTIONAL ACTIVATED SLUDGE
2. QUIT

WHICH NUMBER?

The first line identifies the program disk in use. This is for the users information only. If you have accidentally inserted the wrong diskette, turn the computer off, remove the diskette and start over again.

Note: To repeat a previous warning, wait until the "in use" light is off before removing diskettes from the drives.

The second line is actually a user option, rather than a necessary next step. If the user wishes to save data points for plotting, a Data Disk should be inserted in Drive 2 at this point. If the user does not want to do any plotting on this run, this statement can be ignored

and Drive 2 left empty.

The next three lines give the user a choice of proceeding with the run (Line "1") or stopping (Line "2"). To choose, type the number preceding the statement you wish to follow and then hit <RETURN>¹ button. In either case, the disk drive will whirl and clack for several seconds. If the user typed <1>, the main program is now being loaded into the computer. This will give the user several seconds to get ready for the next steps. If the user typed <2>, the computer would stop running the diagnostic program and could be used for other purposes.

From here on, the computer will ask you many questions in fairly rapid succession before beginning the run. Take your time in answering them. The computer will wait patiently for each answer. However, if you answer a question incorrectly and hit <RETURN>, in most cases the incorrect answer cannot be changed, and you may have to start all over again in order to enter the information you want.

The next questions the computer will ask are:

ENTER TREATMENT PLANT NAME:

STATE OF:

COMMENTS:

Answers to the first two questions will appear exactly as they are entered on the title page of the run. They will appear on the same line with a comma in between.

"COMMENTS" allows the user to add a one line notation to the bottom of the title page. The user should type comments exactly as s/he would like them to appear. Hit <RETURN> to conclude the comments. Remember that only one line of comments can be added. Additional lines will print over the first line.

If the user does not wish to add any comments, simply hit <RETURN>.

¹ From here on, the symbols enclosed in < > symbols refer to specific keys, commands or symbols which the user should press.

3.3 Entering Plant Configuration Data

The next series of questions the computer will ask involve the configuration of each major unit process element in the treatment plant. There are, as mentioned previously, two ways to do this. One is to use data which was previously stored on the program disk under a file name. The other is to enter new data, which can later be stored under a new file name so it can be retrieved and reused later.

The first question the computer will ask is:

DO YOU WISH TO USE PREVIOUSLY ENTERED PLANT CONFIGURATIONS (Y/N).

Before answering this question, the user should understand that the computer assumes that each process unit included in a plant configuration file is on line. There is no way to tell the computer that one or more clarifiers, aeration basins, trickling filters, etc., which are part of a previously entered configuration file, have been taken out of service. Nor is there any way to change a data file. If the user wishes to simulate a plant whose entire configuration is on file--but with one or more units out of service--a new set of plant data must be entered.

Note: There is no way to check the contents of a plant configuration file except to run the file and check the data which is printed out on the first few pages of output.

Using Previously Stored Data

If the user elects to use a previously entered file, the response should be <Y> followed by <RETURN>. The computer will then ask:
UNDER WHAT NAME (IF YOU DON'T KNOW TYPE <?> <RETURN>).

Every plant configuration file has a name assigned to it by the user who created it. The user wishes to use a previously entered plant file, he or she should type in the desired file name, exactly as it was entered, and then hit <RETURN>. The disk drive will whirl and clack a bit more as the file is read in to the computer.

If the user doesn't know the exact file name, hitting <?> <RETURN> will display the names of all the configuration files stored on the program disk, and then repeat the last question. The user can then check the file list, and enter the proper file name.

If the user enters a previously stored plant configuration file by either of these paths, the next question the computer will ask is:

PLEASE ANSWER ALL OF THESE QUESTIONS

AVERAGE DRY WEATHER FLOW MGD

This signals the beginning of the next series of questions which involve entering the wastewater characteristics that will be used in the run. At this point, we will backtrack a bit, and consider what the user should do if he or she does not want to use a previously stored data file.

Using New Data

If the user wants to enter new plant data for a particular run, the user should have typed <N> <RETURN> in response to the first question considered in this section. The <N> response prompts the computer to move on to the next series of questions, which involve the wastewater characteristics that will be used in the simulation. These questions, and the effects of responses to each question, are discussed in section 3.4.

However, the computer would soon return to the questions needed to enter a new plant configuration file. These questions will therefore be discussed now, although it is a bit out of sequence. This is done because answering the plant configuration questions requires a considerable amount of information, which is best gathered ahead of time.

The forms contained in Appendix C are provided to serve as a guide to the information needed in order to answer the computer's questions. The information required is slightly different for each type of treatment plant. If the appropriate sheets in Appendix C are prepared ahead of time, entering the data is a simple matter. Just answer the questions in the order in which they are asked, hitting <RETURN> after each response.

Again, take your time in answering the computer's questions so as not to make a mistake. There is no practical way to change an incorrect number once the <RETURN> button has been hit. The only recourse if this happens is to hit <RESET> and type <RUN> <RETURN>. This will return the program to the very beginning, and the user will have to start all over again.

When the last bit of information needed to complete the plant configuration file has been entered, the computer will acknowledge it by asking the user:

DO YOU WANT TO SAVE THESE VALUES IN A FILE (Y/N)

If the user does want to save the values, typing <Y> <RETURN> will bring the following response:

UNDER WHAT NAME (KEEP IT SHORT)

Type in a name, usually the city that the treatment plant serves (but it can be any combination of letters, numbers and symbols) and hit <RETURN>. The values previously entered will be permanently stored in a file with that name. The disk drive will whir and clack for a few seconds while this is being done.

If the user does not want to save the values, type <N> <RETURN> and proceed. Proceeding at this point would actually bring the user to the beginning of Section 3.5. However, we will again break sequence somewhat and discuss the wastewater characteristics questions, which would actually have been asked before the above questions if the user had not used previously entered plant configuration data.

Note: If the plant being run does not have primary clarifiers, and the program diskette in use requires them unless screens are used, don't try to fool the computer by putting in a "dummy" clarifier with an extremely small diameter and shallow depth. The results will not be realistic. However, a "dummy" digester can be used as all of the diagnostic programs require digesters in the input data. "Dummy" digesters will not produce misleading information in the output.

3.4 Entering Wastewater Characteristics

Entering the wastewater characteristics needed to run the Diagnostic Operational Modeling Programs is quite easy. There are only 13 questions that are asked and some of them don't have to be answered. Some of the questions will have default values assigned to them if there is no data available. These variables, and their default values, are as follows:

% Volatile	80%
TKN	30 mg/l
Alkalinity	100 mg/l
pH	7.0 S.U.
PO ₄ -P	8 mg/l

A realistic value must be assigned to all other wastewater characteristics for the computer to be able to complete the run.

Note: The computer considers a range of flows beginning at 75 percent of the number entered as "AVERAGE DRY WEATHER FLOW," which is the first question asked in this section. This number can therefore be set to achieve a desired minimum flow in the printout. Any deviation from actual conditions will, to a certain degree, affect the accuracy of the model's output at flows less than the actual average flow.

Note: The computer considers a range of flows ending at 130 percent of the number entered as "DESIGN FLOW," which is the third question asked in this section. This number can also be set to achieve a desired maximum flow in the printout. This will also, to a certain degree, cause some deviation from actual expected conditions.

All wastewater values should be entered as accurately as possible to ensure that the mathematical portions of the Diagnostic Operational Modeling Programs have realistic numbers to work with. If they don't, the output will have little value.

3.5 Other Options

After all information described previously in this section regarding the treatment plant configuration and wastewater characteristics has been entered, the user will have three additional options to exercise. They will appear, one by one, as follows:

WOULD YOU LIKE TO SAVE ALL THE DATA POINTS (Y/N)

WOULD YOU LIKE A DIGESTER ANALYSIS (Y/N)

CLOCK (Y/N)

The first question refers to the data points that will be needed for the plotting program. If the user has already decided that he or she wishes to plot the output data, they should first check to make sure that the data disk has been inserted in Drive 2. If not, insert it now, then hit <Y> <RETURN>. If the user does not want any graphical displays of the output, simply hit <N> <RETURN>.

The second question gives the user the option of having digester calculations performed in addition to the other process calculations performed by each program.

The third question gives the user the option of having the date, time, and year printed out on the title page and on the process calculation pages of each run.

Note: The user can answer <Y> or <N> to any of the last three questions. None of these questions affect the accuracy of the process calculations.

The printer should now be put "On-Line." The printer will go to work immediately, and will print for several minutes. Each page of output will have an identifying title at the top, as well as the influent temperature, BOD and TSS concentrations, and (optionally) the date and time of the run. When the run is finished, the printer will advance the paper to the next page, and the disk drive will whirl and clack again. After a few seconds, the message:

ANOTHER RUN (Y/N)

will appear on the screen. This signifies that the main program run is completed.

Note: The "in use" light on the disk drive will come on at various times while the program is running and when the run is completed. For the third time, remember: Never try to remove a diskette from the drive while the "in use" light is on.

3.6 Additional Runs

Once a program has been run through to completion once, the user can rerun the same program and treatment plant configuration file over and over again with new wastewater characteristics. There are limitations, however. The only wastewater characteristics which can be varied are the BOD, TSS and temperature.

If another run is desired with these three variables (or, in fact, none of them) changed, the user can type <Y> <RETURN>. The next three questions which will appear on the screen are:

NEW BOD

NEW TSS

NEW TEMP

The computer will assume that all other plant configuration and wastewater parameters are the same as the first run. There is no practical way to change any other previously entered variable.

Three additional questions will appear on the screen before the next run is started. These are:

STILL SAVE ALL THE DATA POINTS (Y/N)

UNDER WHAT NAME (DIFFERENT FROM THE LAST ONE)

WOULD YOU LIKE A DIGESTER ANALYSIS (Y/N)

If the user wishes to save the new data points, the proper responses to the first two questions are as described in Section 3.3, except that a new file name must be entered. The digestion option has already been discussed in Section 3.5.

3.7 Plotting Program

Selecting the Right File

If the user wishes to use the plotting program, the following steps should now be taken:

- 1) Turn off the power to the computer
- 2) Remove the program disk from Drive 1
- 3) Insert the "Plot Program" disk in Drive 1
- 4) Turn the power to the computer back on

A list of program plot options will then appear on the screen. Pick the program which was just run, enter the appropriate number, and hit <RETURN>.

The computer will then ask you:

WHICH PLANT DO YOU WANT TO PLOT FOR ('?' FOR CATALOG).

The user should enter the name that the data point file was assigned. If more than one data point file with the same name has been stored but with different BOD, TSS and temperature values used during the runs, it is probably best to hit <?> <RETURN>. This will display a series of file names with the following form:

X Y/Z/A

X corresponds to the original data point file name

Y corresponds to the influent BOD on a particular run

Z corresponds to the influent TSS on a particular run

A corresponds to the influent temperature on a particular run.

The first step is to enter the name of the plant file you wish to plot that corresponds to the "X" in the symbolic notation. For example, if the user wished to plot a data file whose name was recorded as "FRED 200/200/20," the user should type FRED> and then hit <RETURN>.

The computer will then ask a series of three questions to determine the influent BOD, TSS and temperature, which corresponds to the Y, Z, and A symbols in the previous example. By entering the appropriate numbers for these three variables, the user can choose the desired file

from several which begin with the same name. After entering these three values, the disk drive will whirl and clack for a few seconds, while it locates the file.

Running the File

The next three statements the computer will make must be well understood before the plot program can be used effectively, although they do not require any answers. They are as follows:

DIRECTIONS ON HOW TO PLOT A VALUE

1. YOU SHOULD HAVE AN EXAMPLE RUN OF THE PLANT
2. YOU SHOULD BE FAMILIAR WITH THE TERMS: PAGE, COLUMN AND ROW
3. YOU SHOULD READ ALL MATERIALS THAT PERTAIN TO THIS PROBLEM

HIT RETURN TO CONTINUE

The plot program asks the user which parameter is to be plotted by page and column number, "Page number" refers to the pages of output from the main program, but the cover page and plant configuration pages are not included in the numbering system. Thus page one is the first page of printed numerical values. The following pages are numbered sequentially. "Column number" refers to the vertical columns of numerical values which appear on each of the "numbered" pages of output. The column numbers begin at the left side of the page, and increase to the right. Thus the plant flow is always column "one," and other variables have higher column numbers.

Most users cannot remember the exact page and column numbers of variables they wish to plot. This is why it is a good idea to have the main program run, or a similar run, at hand. The user can check these numbers on the output and avoid mistakes and lost time.

The third comment is intended to steer users toward this section of the manual before proceeding any further. There are no materials which pertain to the plot program other than those contained in this manual.

The user should now check the program output and select the page and column numbers for the first parameter to be plotted. Enter these numbers, hitting <RETURN> after each is typed in. When the page number is entered, a long series of numbers will appear on the CRT screen. This shows that the numerical data from that page which was stored on the data disk is now being fed into the computer. After the column number is entered, the computer will ask for:

PARAMETER NAME

Choose this name carefully. It will appear on the plot as FLOW vs (PARAMETER NAME). The name entered does not have to be the same as the parameter name used in the main program.

The computer will also ask for:

TITLE OF REPORT

This title can be anything the user wishes and it, too, will appear on the plot as the first line of the heading. All other questions and options used in the plot program are basically self-explanatory while the program is being run, and so will not be described in detail.

3.8 Ending a Run

When the user has finished with the computer, it can be left on for someone else's use with no harm to the equipment. If it is left on, a diskette should be left in Drive 1 to prevent someone from accidentally starting a run with an empty drive. This can be harmful to the disk drive itself. The drive "door" should also be flipped up to take pressure off the diskette. As long as the computer is turned on, the diskettes can be left in the drives for extended periods of time without harm.

Note: It will not hurt the computer to leave a question, such as ANOTHER RUN? (Y/N) unanswered. In fact, leaving this message on the screen is a good indicator of the computer's status, and may be helpful to other users.

If no one else plans to use the computer for several hours, it would be best to turn the computer off. To do this, simply remove the diskettes from both drives and then turn off the power to the computer, printer and CRT.

CHAPTER 4

INTERPRETING THE OUTPUT

This chapter presents an introduction to interpretation of the Diagnostic Operational Modeling Programs' output. It is only an introduction. A full understanding of the model's output requires a considerable knowledge of sanitary engineering and of the treatment plant being modeled. In order to fully understand the operating conditions in any treatment plant, an on-site visit by qualified operations specialists is almost always necessary. Two of the most important objectives of an on-site visit are to verify the accuracy of the plant's laboratory data and plant configuration, which are the starting points of the evaluation process. Without this knowledge, the user should not attempt to draw final conclusions from the output, as misunderstanding will inevitably lead to error.

Appendices D and E of this manual contain, respectively, definitions of the abbreviated variable names which appear at the top of each column of numerical output, and typical values for many of these parameters. The user should take a few minutes to review these Appendices before proceeding with interpretation of the output.

4.1 Assumptions

The Diagnostic Operational Modeling Programs are intended to simulate treatment plant operation under relatively normal conditions. The output should, therefore, be regarded as an indication of how the plant would perform under ideal, but not unrealistic, conditions. The only limitations the programs consider are those set by the physical dimensions of the plant and by the wastewater characteristics selected by the user. This is why the models are referred to as "idealized."

There are two kinds of limitations which must be considered in interpreting the output of the models. The first are process limitations which may occur in several forms in any treatment plant. These are discussed below. The second are related to the computer algorithms themselves and are discussed in Section 4.2.

The Diagnostic Operational Modeling Programs make the following assumptions:

1. Wastewater is typical domestic sewage, with no significant industrial component, abnormally high variability or unusually high strength recycle flows.
2. The flow split between parallel process units produces uniform organic and hydraulic loading.
3. Clarifiers (both primary and secondary) have minimal short circuiting.
4. Both primary and secondary sludge reach ultimate compaction in the clarifiers.
5. There is no toxic inhibition of biological processes.
6. There is no oxygen limitation in biological processes.
7. Distribution of flow over fixed film biological reactors is uniform.
8. Suspended growth biological reactors are uniformly mixed.
9. Secondary clarifiers in suspended growth biological systems have adequate sludge collector capacity.
10. All unit processes have adequate pump capacity.

These assumptions must be verified before the output of the models can be considered representative of a treatment plant's actual performance capability. Significant deviations from these idealized conditions can limit process performance in a variety of ways. The exact effects of this kind of limitation depend on the specific type of problem, plant configuration, operating strategies and countless other factors, and, therefore, cannot be considered in the modeling programs. For this reason, actual effluent quality in such plants may

be quite different from the model's predictions. If significant process limitations do exist, the output of the models will provide an indication of the effluent quality which could be achieved if these limitations were corrected. Of course, no treatment plant operates under truly ideal conditions, and some minor limitations will always be present. Minor limitations will not, by themselves, lead to a pronounced difference between actual and predicted effluent quality.

4.2 Accuracy of the Algorithms

The algorithms used in the Diagnostic Operational Modeling Programs are intended to be most accurate in the average operating range of most secondary treatment plants. This corresponds to effluent BOD and TSS concentrations of 10 to 50 mg/l, with a maximum monthly average of 30 mg/l being the usual requirement. Within this range, and providing that all the assumptions discussed in section 4.1 are true, the effluent BOD and TSS concentrations predicted by the programs are accurate to within about ten percent.

The accuracy of the algorithms decreases under extremely high or low loading conditions, although efforts have been made to adjust the algorithms under these conditions. When predicted effluent BOD and TSS concentrations are less than 10 mg/l or greater than 50 mg/l, the programs are no longer considered to be accurate to within any fixed percentage limits. Under these conditions, the judgement of the user becomes an important factor in interpretation of the output.

4.3 Detecting Process Limitations

The first step in evaluating a treatment plant's performance should be to compare actual operating data to the predicted performance. If they are essentially equal, it indicates that the plant is operating without significant process limitations. If this is the case, and the plant's effluent quality is very close to its discharge limit, it indicates that thought should be given to retrofitting or expanding the plant if flows are expected to increase in the future. The output will indicate how much additional flow the plant could handle before effluent quality becomes unacceptable.

If a plant is operating without process limitations and is producing a much higher quality effluent than is required by the plant's discharge permit, it indicates that loading on process units is rather light. In cases such as this, it may be possible to shut down one or more process units without degrading effluent quality to an unacceptable level. This can result in a substantial savings in energy and maintenance costs, and prolong the life of plant equipment as well. The Diagnostic Operational Modeling Programs can be used to quickly and accurately predict the impact of removing any combination of process units on the overall performance of the plant.

If, on the other hand, the actual effluent quality at a particular treatment plant is significantly worse than the predicted quality, the difference may be due to one or more specific process limitations. Process limitations, as described in Chapter 1, are conditions which limit the capacity of a particular unit process to the extent that the overall performance of the plant is adversely affected.

Before any attempt is made to diagnose process limitations, the user should understand the following aspects of the algorithms used in the Diagnostic Operational Modeling Programs:

1. In the Conventional Activated Sludge, Single Stage Activated Sludge for Nitrification, Activated Bio-Filter and Contact Stabilization programs, the maximum MLSS concentration in the biological reactors (contactor only in the Contact Stabilization program) is limited to 2500 mg/l. In the Extended Aeration and Extended Aeration Oxidation Ditch programs, the maximum MLSS is limited to 3000 mg/l.

These limits are based on the solids handling capability of most secondary clarifier systems in typical activated sludge and extended aeration treatment plants. Higher mixed liquor concentrations often result in solids overload. Therefore, these values represent an upper limit of normal operation in most plants.

2. In all programs which simulate suspended growth reactors (all those included in items 1 and 2 above), the minimum allowable depth to the sludge blanket in secondary clarifiers is six feet measured from the water surface. This has an interactive effect on the mixed liquor concentration in the biological reactors. When the six foot depth is reached, this interaction causes the mixed liquor concentrations to be lowered to whatever level is necessary to maintain this six foot minimum as flows increase. The effects of this are generally quite noticeable when examining the output.

The most commonly observed process limitations, considered on a process by process basis, are as follows:

Primary Clarifiers

1. Hydraulic overload. This can be observed in the computer output when the surface loading exceeds the high value in Appendix E.
2. Excessive turbulence or short circuiting. This must be verified by on-site inspection.
3. Uneven flow split between clarifiers. This must be verified by on-site inspection.

Suspended Growth Reactors

1. Reactors too small. This can be observed in the computer output when the F/M ratio exceeds the high value in Appendix E and the depth of the sludge blanket is still greater than six feet.
2. Insufficient aeration capacity. This can be observed in plant operating data or verified by on-site inspection.
3. Insufficient mixing. This must be verified by on-site inspection.

Trickling Filters and Activated Bio-Filters

1. Trickling filters too small. This can be observed in the computer output when the lb BOD/1000 ft³/day loadings exceed the high value in Appendix E.
2. Uneven flow distribution over filters. This must be verified by on-site inspection.
3. Filters plugged (ponding). This must be verified by on-site inspection.
4. Excessive recirculation rates. This can be observed in the computer output when the loading in GPDSF exceeds the high value in Appendix E.

Rotating Biological Contactors

1. RBC's too small. This can be observed in the computer output when the lb BOD/1000 ft²/day loadings exceed the high value in Appendix E.
2. Uneven flow split between reactor trains. This must be verified by on-site inspection.

Secondary Clarifiers

1. Same as 1 in "Primary Clarifiers"
2. Same as 2 in "Primary Clarifiers"
3. Same as 3 in "Primary Clarifiers"
4. Clarifiers too shallow. This can be observed in the computer output for suspended growth programs when the depth to the sludge blanket decreases to six feet and mixed liquor concentrations are less than the allowable maximum.

Aerobic and Anaerobic Digesters

1. Digesters too small. This can be observed in the computer output when the mean cell residence time is less than the high loading value in Appendix E.

Note: The digester performance has no direct effect on plant effluent quality in the Diagnostic Operational Modeling Programs.

Note: Not all of the ten basic assumptions presented in Section 4.1 have been repeated in this summary. The user should keep in mind that they do apply in all cases. Those assumptions which are not specifically repeated must, in general, be verified by on-site inspection.

The user should check each value in the computer output against the ranges presented in Appendix E and against actual plant data, if possible, to check for unusual conditions in all unit processes.

Often, several abnormal conditions are related to a single process limitation. The user should also keep in mind that there are numerous process limitations which may be related to specific equipment in use at a particular treatment plant. A meaningful analysis of the output from each computer run should include a discussion of the run with the plant superintendent to identify any such limitations and determine their effects on plant performance and on the computer's predictions.

4.4 Detecting Operational Deficiencies

If the actual performance of a treatment plant is not as good as the computer predicts it could be, and no process limitations are identified, the problems may be caused by operational deficiencies. The best way to identify operational deficiencies is through careful comparison of plant laboratory data with the operating parameters predicted in the computer runs. Discussion of the data and runs with plant personnel is especially important in this situation.

Identifying operational deficiencies also requires a much more thorough understanding of plant operation itself than is needed to identify process limitations. The experience of a well-qualified operations specialist can be extremely beneficial when reviewing and interpreting plant data.

There are countless operational problems which can adversely affect the overall performance of a treatment plant. It is, therefore, impossible to present a comprehensive set of guidelines for identifying such problems. However, the following list of commonly encountered situations which can lead to poor plant performance is provided to orient the user towards sources of operational problems and methods of solving them. They are:

Laboratory Sampling and Analysis

1. Improper sampling technique. Many treatment plants rely on grab samples rather than composite samples. Grab samples are often misleading in terms of average daily conditions.
2. Improper sampling location. Sampling locations must be chosen to accurately account for recycle flows, intermittent process pumping, and other variable factors.
3. Insufficient sampling. In a few cases, the amount of laboratory data available is simply insufficient to allow a realistic process analysis or proper process control.
4. Improper laboratory procedures. In a few cases, analytical procedures are applied improperly and produce incorrect results. This creates a totally false representation of actual conditions at the plant.

Routine and Emergency Maintenance

1. Routine maintenance. The proper performance of routine maintenance is essential to the everyday operation of process equipment. If this maintenance is not done properly, the frequency of equipment failure will increase to the detriment of overall plant performance.
2. Emergency maintenance. Each piece of process equipment has a useful life. If a plant is rather old and much of the process equipment is badly worn, a high rate of equipment failure and emergency repair is inevitable. This, too, will limit process performance.

Process Control

1. Inadequate training. In some plants operations personnel do not have the necessary understanding of process control theory or practice to maintain an effective overall operation. Training is the only method of correcting this problem.
2. Inadequate staffing. Some plants are understaffed due to personnel transfer or insufficient operating budget. When this happens, process control work is frequently the lowest priority of the available staff, and plant performance often suffers.

Influent Wastewater

1. High variability. In some communities, particularly small ones, the strength of the wastewater is highly variable. This can reduce treatment efficiency even if all other operational considerations are well managed.
2. Shock loads. Rapid, short term changes in the influent wastewater characteristics can be particularly detrimental to treatment plants. Discharges from metal plating, food processing and other commercial and industrial sources are frequently the cause of such problems.

Other Causes

1. Lack of process control capability. Some treatment plants lack the flexibility required to adjust to changing conditions. Others lack instrumentation needed to regulate process adjustments. Both of these problems can lead to substandard effluent quality.
2. Process upsets. Filamentous growths, excessive sloughing and other causes can lead to temporary increases in effluent BOD and TSS concentrations. To a certain extent, these problems will occur from time to time in all treatment plants. With sufficient process capability, these problems can be corrected in a relatively short period of time.

4.5 Special Considerations in Output Interpretation

The Diagnostic Operational Modeling Programs are most accurate in the normal operating range of most treatment plants. The algorithms used in the programs lose some accuracy under unusually high or low plant loadings, although the results are still indicative of actual plant performance. However, if unrealistically high or low loadings are simulated, the algorithms will not produce realistic predictions.

Some examples of these conditions are:

1. The primary clarifier efficiency algorithms never go to zero. They will always predict a 10 to 15 percent removal of BOD and TSS even as the surface loading approaches infinity.
2. The secondary clarifier efficiency and effluent quality algorithms for suspended growth biological systems predict astronomical effluent BOD and TSS concentrations at extremely high secondary clarifier surface loading rates.
3. The contact stabilization program will sometimes "bomb" mathematically when F/M ratios in the contactors or reaeration tanks exceed 2.0 or 1.0, respectively. In actual operation, a plant would fail totally long before these values were reached.
4. The aerobic digester routines in the Extended Aeration and Extended Aeration Oxidation Ditch programs will not produce accurate results when the MCRT in the biological system drops below 15 days.

The numerical values presented in Appendix E should serve as an example of the range of values where the Diagnostic Operational Modeling Programs will produce reasonably accurate results. At conditions above or below these ranges, the users judgement must be used to determine when the limits of accuracy of the programs have been reached.

Note: The effluent BOD and TSS concentrations predicted by the Diagnostic Operational Modeling Programs are the concentrations in the secondary clarifier effluent. They are not intended to represent final effluent quality. Chlorination can cause a measurable amount of suspended solids to settle out of secondary clarifier effluent. This phenomenon has been observed at numerous treatment plants, and is particularly noticeable in plants which are overloaded and produce a rather poor quality secondary effluent. The Diagnostic Operational Modeling Programs do not account for this effect.

APPENDIX A
ALGORITHM SOURCES

A-1

APPENDIX A
ALGORITHM SOURCES

The algorithms used in the Diagnostic Operational Modeling Programs were prepared solely by:

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Assistance with development of the program formats and preparation of this manual was provided solely by:

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Thomas T. Jones
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APPENDIX B
INFLUENT AND EFFLUENT WASTEWATER
DATA SHEETS

B-1

APPENDIX B
INFLUENT AND EFFLUENT WASTEWATER
DATA SHEETS

Treatment Plant Name: _____

Location (in what state): _____

Wastewater Characteristics Input Data:

Average dry weather flow	_____	(MGD)
Average wet weather flow	_____	(MGD)
Peak dry weather flow	_____	(MGD)
Peak wet weather flow	_____	(MGD)
Design dry weather flow	_____	(MGD)
Design peak wet weather flow	_____	(MGD)
Influent BOD	_____	(mg/l)
Influent TSS (total suspended solid)	_____	(mg/l)
Influent VSS ^{1,2} (volatile suspended solids)	_____	(%)
Temperature (maximum/minimum)	_____/_____	(°C)
TKN (total Kjeldahl nitrogen) ²	_____	(mg/l)
Alkalinity ²	_____	(mg/l)
pH ²	_____	
PO ₄ -P (Orthophosphates) ²	_____	(mg/l)

- Footnotes: 1. Be sure that this value is expressed as a percentage of total suspended solids, rather than a concentration in mg/l.
2. If you are not sure about these values, just leave them blank; default values will be assigned by the computer programs.

Effluent Characteristics (existing)

	<u>Avg. wet weather flow</u>	<u>Avg. dry weather flow</u>
BOD	_____	_____
TSS	_____	_____
VSS	_____	_____
pH	_____	_____
TKN	_____	_____
NO ₃	_____	_____

Plant Superintendent

Name _____

Phone No. () _____

APPENDIX C
TREATMENT PLANT CONFIGURATION
DATA SHEETS

C-1

APPENDIX C

TREATMENT PLANT CONFIGURATION
DATA SHEETS

Treatment Plant Name _____

State of _____

Type of Treatment Plant (check appropriate box)

- ☐ 1. Primary treatment
- ☐ 2. Conventional activated sludge, with or without primary sedimentation
- ☐ 3. Single stage activated sludge for nitrification, with or without primary sedimentation
- ☐ 4. Extended aeration with or without primary sedimentation
- ☐ 5. Extended aeration oxidation ditch with or without primary sedimentation
- ☐ 6. Contact stabilization, with or without primary sedimentation
- ☐ 7. Single stage trickling filter with primary sedimentation
- ☐ 8. Two stage trickling filter with primary sedimentation
- ☐ 9. Activated Bio-Filter Process, with or without primary sedimentation
- ☐ 10. Rotating biological contactors with primary sedimentation

1. Primary Clarification Input Data:

Circular Clarifiers

Clarifier Number	#1	#2	#3	#4	#5
------------------	----	----	----	----	----

Diameter of ea. clarifier (ft)

Avg. depth of ea. clarifier (ft)

Weir length of ea. clarifier (ft)

Rectangular Clarifiers

Clarifier Number	#1	#2	#3	#4	#5
------------------	----	----	----	----	----

Length of ea. clarifier (ft)

Width of ea. clarifier (ft)

Avg. depth of ea. clarifier (ft)

Weir length of ea. clarifier (ft)

Fine Screen

Are fine screens being used (yes or no): _____

If yes, answer the following questions:

Type of screen: _____

Number of screens: _____

Width (ft): _____

Height (ft) _____

Screening opening: (in): _____

Capacity ea. (MGD): _____

2. Secondary Clarification Input Data:

Circular Clarifiers

Clarifier Number	#1	#2	#3	#4	#5
------------------	----	----	----	----	----

Diameter of each clarifier (ft)

Avg. depth of ea. clarifier (ft)

Weir length of ea. clarifier (ft)

Rectangular Clarifiers

Clarifier Number	#1	#2	#3	#4	#5
------------------	----	----	----	----	----

Length of ea. clarifier (ft)

Width of ea. clarifier (ft)

Avg. depth of ea. clarifier (ft)

Weir length of ea. clarifier (ft)

3. Reactor(s) Input Data:

Type of Reactor: circle the type of reactor shown below and indicate the dimensions for each of the reactors

Activated Sludge/Extended Aeration

Circular Reactors (Aeration Basins)

Reactor Number	#1	#2	#3	#4	#5
----------------	----	----	----	----	----

Diameter (ft)

Water depth (ft)

Rectangular Reactors (Aeration Basins)

Reactor Number	#1	#2	#3	#4	#5
----------------	----	----	----	----	----

Length of ea. basin (ft)

Width of ea. basin (ft)

Avg. depth of ea. basin (ft)

Extended Aeration Oxidation Ditch

Ditch Number	#1	#2	#3	#4	#5
--------------	----	----	----	----	----

Volume of ea. ditch (gal)

Contact Stabilization

Round Reaeration Tanks

Tank Number	#1	#2	#3	#4	#5
-------------	----	----	----	----	----

Volume of ea. tank (MG)

Rectangular Reaeration Tanks

Tank Number	#1	#2	#3	#4	#5
-------------	----	----	----	----	----

Length of ea. tank (ft)

Width of ea. tank (ft)

Avg. depth of ea. tank (ft)

Round Contact Tanks

Tank Number	#1	#2	#3	#4	#5
-------------	----	----	----	----	----

Volume of ea. tank (MG)

Rectangular Contact Tanks

Tank Number	#1	#2	#3	#4	#5
-------------	----	----	----	----	----

Length of ea. tank (ft)

Width of ea. tank (ft)

Avg. depth of ea. tank (ft)

Activated Bio-Filter (ABF)

Bio-tower media (circle one): Redwood, stacked plastic, packed plastic

Are bio-towers constant flow or constant recirculation:

<u>Circular Bio-Filters</u>	<u>#1</u>	<u>#2</u>	<u>#3</u>	<u>#4</u>	<u>#5</u>
Diameter of ea. bio-filter (ft)					
Depth of ea. bio-filter (ft)					
Flow rate (GPM)					

<u>Rectangular Bio-Filters</u>	<u>#1</u>	<u>#2</u>	<u>#3</u>	<u>#4</u>	<u>#5</u>
Length of ea. bio-filter (ft)					
Width of ea. bio-filter (ft)					
Depth of ea. bio-filter (ft)					
Flow rate (GPM)					

Circular Aeration Basins

<u>Reactor Number</u>	<u>#1</u>	<u>#2</u>	<u>#3</u>	<u>#4</u>	<u>#5</u>
Diameter (ft)					
Avg. depth (ft)					

Rectangular Aeration Basins

<u>Reactor Number</u>	<u>#1</u>	<u>#2</u>	<u>#3</u>	<u>#4</u>	<u>#5</u>
Length of ea. basin (ft)					
Width of ea. basin (ft)					
Avg. depth of ea. basin (ft)					

Activated Sludge/Extended Aeration/Contact Stabilization/ABF

Type of aeration (circle one): diffused air, mechanical aeration

<u>Tank Number</u>	<u>#1</u>	<u>#2</u>	<u>#3</u>	<u>#4</u>	<u>#5</u>
diffused: scfm/reactor					
mechanical: hp/reactor					

Single Stage Trickling Filter

Filter media (circle one): rock, stacked plastic, packed plastic

Are filters constant flow or constant recirculation:

Filter number	#1	#2	#3	#4	#5
---------------	----	----	----	----	----

Diameter of ea. filter (ft)

Depth of ea. filter (ft)

Flow rate (GPM)

Two Stage Trickling Filter

Primary Filter media (circle one): rock, stacked plastic, packed plastic

Are filters constant flow or constant recirculation:

Primary Filter Number	#1	#2	#3	#4	#5
-----------------------	----	----	----	----	----

Diameter of ea. filter (ft)

Depth of ea. filter (ft)

Flow rate (GPM)

Secondary Filter Media (circle one): rock, stacked plastic, packed plastic

Are filters constant flow or constant recirculation:

Secondary Filter Number	#1	#2	#3	#4	#5
-------------------------	----	----	----	----	----

Diameter of ea. filter (ft)

Depth of ea. filter (ft)

Flow rate (GPM)

Rotating Biological Contactor (RBC)

Manufacturer of RBC units _____

Type of drive unit (air or mechanical) _____

No. of process trains _____

No. of stages per train _____

Stage No. 1 surface area/per stage _____ ft^2

Stage No. 2 " " " " _____ ft^2

Stage No. 3 " " " " _____ ft^2

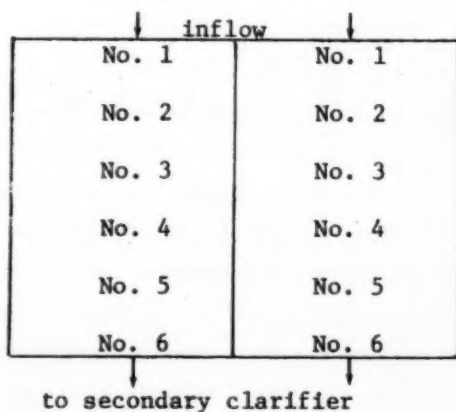
Stage No. 4 " " " " _____ ft^2

Stage No. 4 " " " " _____ ft^2

Stage No. 5 " " " " _____ ft^2

Stage No. 6 " " " " _____ ft^2

Example:



In example there are two trains with six stages in series. Stage Nos. 1,2,3 in each train have 100,000 ft^2 of surface area each or a total of 600,000 square feet. Stages Nos. 4,5,6 have a surface area of 150,000 ft^2 each or a total of 900,000 ft^2 .

4. Sludge Digestion Input Data:

Anaerobic Digestion

Primary Digesters

Tank Number	#1	#2	#3	#4
-------------	----	----	----	----

Volume of each primary digester _____ gallons

Are the digesters heated _____ (yes or no)

Are the digesters mixed _____ (yes or no)

Is there any type of thickening prior to digestion? If so what kind

Secondary Digesters

Tank Number	#1	#2	#3	#4
-------------	----	----	----	----

Volume of each digester	gallons
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
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Can the digesters be heated _____ (yes or no)

Can the digesters be mixed (yes or no)

Aerobic Digestion

Tank Number	#1	#2	#3	#4
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Volume of each digester _____ gallons

Is there any type thickening prior to digestion? If so what type

APPENDIX D

DEFINITION OF OUTPUT PARAMETERS

D-1

PRIMARY CLARIFIER

FLOW	=	Hydraulic flow rate of the wastewater treatment plant; expressed in million gallons per day (MGD).
PCE BOD	=	Concentration of BOD ₅ of primary clarifier effluent (mg/l).
PCE TSS	=	Concentration of total suspended solids of primary clarifier effluent (mg/l).
PS	=	Primary sludge; production rate (lbs/day), solids content expressed in lbs. of dry solids per lb. of sludge in terms of percentage (%) and flow rate (gallons/day).
SL	=	Surface loading or overflow rate of the primary clarifier (gal/ft ² /day).

BIOLOGICAL PROCESS PARAMETERS

MAX MLSS	= Maximum value of the mixed liquor suspended solids concentration (mg/l).
MLVSS	= Mixed liquor volatile suspended solids (%).
F/M	= Food to microorganism ratio (dimensionless).
MCRT	= Mean cell residence time of biological reactors (days).
SVI	= Sludge volume index; defined as the volume in ml occupied by one gram of mixed liquor solids after 30 minutes settling.
RAS	= Return activated sludge; flow rate (MGD) and concentration (mg/l).
WAS	= Wasted activated sludge; mass flow rate (lbs/day).
DET TIME	= Hydraulic detention time, (hrs) and (days).
LOAD	= Activated Sludge, Extended Aeration and Contact Stabilization Systems - expressed in lbs BOD ₅ per 1000 ft ³ of reactor volume (lbs BOD ₅ /1000 ft ³).
	- All Trickling Filter and ABF Systems - expressed in lbs BOD per 1000 ft ³ of media volume (lbs BOD ₅ /1000 ft ³).
	- RBC systems - expressed in lbs BOD per 1000 ft ² of media surface (lbs BOD ₅ /1000 ft ²).
OUR	= Oxygen uptake rate (mg/l/hr).
O ₂ RQD	= Oxygen requirement (lbs/day).

SECONDARY CLARIFIER

DOB	=	Depth of blanket (ft). (Measured from surface)
EFF BOD	=	Effluent concentration of BOD ₅ (mg/l).
EFF TSS	=	Effluent concentration of total suspended solids (mg/l).
EFF NO ₃	=	Effluent concentration of nitrate nitrogen (mg/l).
EFF PO ₄ -P	=	Effluent concentration of orthophosphates (mg/l).
CLARIFIER LOAD	=	Hydraulic loading of the secondary clarifier; surface loading (gal/ft ² /day) and weir loading (gal/ft of weir length/day).
SEC. SLUDGE PROD	=	Sludge production from secondary clarifier per day; expressed in lbs. of total suspended solids (lbs/day) and in lbs. of volatile suspended solids (lbs/day).
TOTAL SLUDGE PROD	=	Total sludge production from both primary and secondary systems per day; in terms of lbs. of TSS (lbs/day), lbs of VSS, (lbs/day) and in terms of flow rate (gal/day); it is characterized by its solids content in terms of percent solids (% SOL).

DIGESTER

TOTAL SLUDGE FLOW	=	Total sludge flow rate into the primary digester (gal/day); or as previously defined under the title "Total Sludge Prod."
VSS LOADING	=	Volatile suspended solids loading to the primary digesters expressed in lbs of VSS loaded per ft ³ of digester per day (lbs/ft ³ /day).
MCRT	=	Mean cell residence time in the primary digesters (days).
% VSS RED.	=	Volatile suspended solids reduction (%); in the primary digesters.
ALK.	=	Alkalinity (mg/l), in the primary digester.
GAS PRO.	=	Gas production (ft ³ /day), from the primary digesters.
% SOL. DIG. SLUDGE	-	In the digested sludge going to the secondary digesters.

APPENDIX E
REPRESENTATIVE VALUES FOR OUTPUT PARAMETERS

E-1

PRIMARY TREATMENT SYSTEM

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
Surface Loading (GPDSF)	400	800	1500
Weir Loading (GPD/FT)	8000	20,000	40,000
Detention Time (Hrs.)	4.0	2.0	1.0
BOD ₅ Percent Removal	40	25	15
TSS Percent Removal	70	50	30

SECONDARY TREATMENT SYSTEM

Conventional Activated Sludge

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
MAX MLSS (MG/L)	2500	2500	<2500
MLVSS (%)	60	75	85
F/M	0.10	0.30	0.40
MCRT (DAYS)	20	7	3
SVI	100	100	>150
DET. TIME (HRS)	8	6	3
LB BOD/1000 FT ³	20	50	75
OUR (MG/L/HR)	10	20	40
CLARIFIER LOAD			
- SFC (GPSFD)	200	400	600
-WEIR (GPLFD)	8000	12,000	16,000

SECONDARY TREATMENT SYSTEM

Single Stage Activated Sludge for Nitrification

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
MAX MLSS (MG/L)	2500	2500	<2500
MLVSS (%)	60	75	85
F/M	0.10	0.30	0.40
MCRT (DAYS)	25	10	7
SVI	100	100	>150
DET. TIME (HRS)	10	8	4
LB BOD/1000 FT ³	20	50	75
OUR (MG/L/HR)	10	20	40
CLARIFIER LOAD			
- SFC (GPSFD)	200	400	600
-WEIR (GPLFD)	8000	12,000	16,000

SECONDARY TREATMENT SYSTEM

Activated Bio-Filter (Biological Reactor Performance page)

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
MAX MLSS (MG/L)	2500	2500	<2500
MLVSS (%)	60	75	85
F/M	0.10	0.30	0.40
MCRT (DAYS)	15	6	3
SVI	100	100	>150
DET. TIME (HRS)	8	6	3
LB BOD/1000 FT ³	20	50	75
OUR (MG/L/HR)	10	20	40
CLARIFIER LOAD			
- SFC (GPSFD)	200	400	600
-WEIR (GPLFD)	8000	12,000	16,000

SECONDARY TREATMENT SYSTEM

Extended Aeration
Extended Aeration Oxidation Ditch

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
MAX MLSS (MG/L)	3000	3000	<3000
MLVSS (%)	60	65	75
F/M	0.10	0.15	0.2
MCRT (DAYS)	40	30	20
SVI	100	100	150
DET. TIME (HRS)	36	24	12
LB BOD/1000 FT ³	5	15	25
OUR (MG/L/HR)	5	10	25
CLARIFIER LOAD			
- SFC (GPSFD)	200	400	600
- WEIR (GPLFD)	8,000	12,000	16,000

SECONDARY TREATMENT SYSTEM

Contact Stabilization

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
<u>Contactor</u>			
MAX MLSS (MG/L)	2500	2500	<2500
MLVSS (%)	55	70	85
F/M	0.60	0.90	1.20
MCRT (DAYS) *	20	7	3
SVI	100	100	150
DET. TIME (HRS)	6.0	3.0	1.0
OUR (MG/L/HR)	15	30	50
LB BOD/1000 FT ³	40	75	100
<u>Reaeration Tank</u>			
MAX MLSS (MG/L)	10,000	10,000	<7,000
F/M	0.10	0.15	0.20
<u>Clarifier Load</u>			
- SFC (GPSFD)	200	400	600
- WEIR (GPLFD)	8,000	12,000	16,000

* Aggregate of contactor and reaeration tanks

SECONDARY TREATMENT SYSTEM

Single Stage Trickling Filter
Two Stage Trickling Filter
Activated Bio-Filter (Secondary System Loading page)

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
<u>Single Stage Trickling Filter</u>			
FILTER LOADING (GPDSF)	200	800	1500
FILTER LOADING (#BOD/1000 FT ³)	10	25	40
RECIRCULATION RATIO (%)	0	100	200
<u>Two Stage Trickling Filter (First Stage) and Activated Bio-Filter (Secondary System Loading page)</u>			
FILTER LOADING (GPDSF)	200	800	1500
FILTER LOADING (#BOD/1000 FT ³)	50	100	150
RECIRCULATION RATIO (%)	0	100	200
<u>Two Stage Trickling Filter (Second Stage)</u>			
FILTER LOADING (GPDSF)	200	800	1500
FILTER LOADING (#BOD/1000 FT ³)	10	20	30
RECIRCULATION RATIO (%)	0	100	200
<u>ALL TYPES</u>			
CLARIFIER LOADINGS - SURFACE (GPDSF)	200	600	800
- WEIR (GPD/FT)	8,000	15,000	20,000

SECONDARY TREATMENT SYSTEM

Rotating Biological Contactors

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
STAGE LOADING*			
STAGE 1 (#BOD/1000 FT ²)	1.0	2.0	3.5
TOTAL (#BOD/1000 FT ²)	0.5	1.0	1.5
CLARIFIER LOADINGS - SURFACE (GPDSF)	200	600	800
-WEIR (GPD/FT)	8000	15,000	20,000

*Total BOD₅

SLUDGE DIGESTION SYSTEM

<u>PARAMETERS</u>	<u>LOW LOADING</u>	<u>NORMAL LOADING</u>	<u>HIGH LOADING</u>
<u>Aerobic Digesters (WAS only)</u>			
VSS LOADING (LB/FT ³ /DAY)	.05	.10	.15
MCRT (DAYS)	30	15	10
% VSS REDUCTION	60	40	20
<u>Anaerobic Digesters (Standard Rate)</u>			
VSS LOADING (LB/FT ³ /DAY)	.05	.10	.15
MCRT (DAYS)	45	30	20
% VSS REDUCTION	75	60	40
<u>Anaerobic Digesters (High Rate)</u>			
VSS LOADING (LB/FT ³ /DAY)	.10	.25	.40
MCRT (DAYS)	30	20	15
% VSSS REDUCTION	70	50	30

APPENDIX F

DO'S AND DON'TS OF
APPLE COMPUTER OPERATION

DO'S AND DON'TS OF
APPLE COMPUTER OPERATION

- DO NOT remove circuit boards in computer while power is on.
- DO NOT turn the computer on unless there is a diskette in Drive 1.
- DO NOT remove a diskette from a drive while the "in use" light is on.
- DO NOT hit reset button while "in use" light is on on either diskette drive.
- DO turn printer on and place it "on line" before running programs.
- DO have paper in printer before turning it on.
- DO NOT manually advance printer paper while printer is on--use LF (line feed) or FF (form feed) buttons instead.
- DO keep equipment in cool (<85° F), relatively dry area.
- DO NOT expose diskettes to magnetic or electrical fields (such as from electric motors), heat, or sunlight.
- DO NOT touch grey surface of diskette with fingers or other object.
- DO keep diskettes in paper packet when not in use.
- DO handle diskettes carefully by plastic cover only.
- DO NOT force diskettes into drives--they should enter smoothly with little effort.
- DO NOT leave diskettes stored in drives overnight.